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RESEARCH ARTICLE

What is the role of trees and remnant vegetation in attracting people to urban parks?

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Abstract Public parks commonly contain important habitat for urban biodiversity, and they also provide recreation opportunities for urban residents. However, the extent to which dual outcomes for recreation and conservation can be achieved in the same spaces remains unclear. We examine whether greater levels of (i) tree cover (i.e. park 'greenness') and (ii) native remnant vegetation cover (i.e. vegetation with high ecological value) attract or deter park visitors. This study is based on the park visitation behaviour of 670 survey respondents in Brisbane, Australia, detailing 1,090 individual visits to 324 urban parks. We first examined the presence of any clear revealed preferences for visiting parks with higher or lower levels of tree cover or remnant vegetation cover. We then examined the differences between each park visited by respondents and the park closest to their home, and used linear mixed models to identify socio-demographic groups who are more likely to travel further to visit parks with greater tree cover or remnant vegetation cover. Park visitation rates reflected the availability of parks, suggesting that people do not preferentially visit parks with greater vegetation cover despite the potential for improved nature-based experiences and greater wellbeing benefits. However, we discovered that people with a greater orientation towards nature (measured using the nature relatedness scale) tend to travel further for more vegetated parks. Our results suggest that to enhance recreational benefits from ecologically valuable spaces a range of social or educational interventions are required to enhance people's connection to nature.

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Introduction

Public parks provide a crucial recreation resource that contributes to the wellbeing of city residents. They provide a location for exercise, social interaction, and reflection (Aldous 2007; Baur and Tynon 2010; Sugiyama et al. 2010), and people with better access to urban parks live longer (Mitchell and Popham

2008), exercise more (Bai et al. 2013; Thompson 2013), have better social cohesion (Kazmierczak 2013), and report better general health (van Dillen et al. 2012). Public parks also provide important habitat for fauna and flora in an otherwise hostile urban landscape (Zhou and Chu 2012), and they have commonly been found to harbour much higher levels of biodiversity than the surrounding urban matrix (Matteson et al. 2013; Strohbach et al. 2013). Thus, public parks and the ecosystems within them provide important recreational ecosystem services for people in cities while also contributing to the sustainability of urban landscapes (Bolund and Hunhammar 1999; Wu 2013, 2014).

Given the dual benefits that people and biodiversity gain from urban parks, ecological restoration could both enhance the sustainability of cities and also deliver public health and wellbeing benefits (Tzoulas et al. 2007; Standish et al. 2013). Certainly, many municipalities have developed park management policies that aim to improve biodiversity conservation and human wellbeing (Sandström et al. 2009). However, little is known about the extent to which outcomes for human recreation and biodiversity can be achieved in the same spaces. One aspect of this issue is whether higher levels of vegetation within parks attracts or deters visitors. For example, are people more or less likely to visit parks with greater levels of tree cover (as a measure of general greenness of a park regardless of ecological value) or native remnant vegetation cover (as a measure of vegetation with high ecological value)?

Public parks also provide a city-based arena for interactions with nature (Fuller et al. 2007). Such interactions are vital for two key reasons. First, they contribute to our physical, social, and mental wellbeing (Ulrich 1984; Bodin and Hartig 2001; Shinew et al. 2004; Maas et al. 2006; Hartig 2008; Han 2009; Dearborn and Kark 2010; Keniger et al. 2013), and some of these wellbeing benefits may actually be greater in more biodiverse areas (Fuller et al. 2007; White et al. 2013). Second, it has been suggested that experiences with nature contribute to the development of pro-environmental attitudes and behaviours (Wells and Lekies 2006). Given that native remnant vegetation cover supports high biodiversity value (Sattler and Williams 1999), public parks with higher levels of this type of vegetation cover are likely to provide particularly important locations for experiences with nature. The question of whether higher levels of tree cover or remnant vegetation cover within parks (as two possible measures of 'nature') attracts or deters visitors is important in this context; if people prefer to visit parks with lower levels of vegetation cover the realised benefits of these nature-interactions could be severely constrained.

A range of social and environmental factors are known to influence park visitation behaviour; this includes gender, age, education and income, which all influence preferences for different types and sizes of parks, as well as the facilities within them (Ho et al. 2005; Wende et al. 2012; Jim and Shan 2013; Zanon et al. 2013; Lin et al. 2014; Pleson et al. 2014). Research into these human-environment interactions provides important insights into how sustainable landscapes might be designed to deliver recreational ecosystem services (Wu 2013). However, the role of vegetation cover in attracting people from different social and demographic backgrounds to parks remains unclear. On the one hand, the wellbeing outcomes of parks might directly motivate people to use them (Kaplan and Kaplan 1989; Home et al. 2012). Indeed, experiencing nature is a commonly stated reason for people to visit public green space (Chiesura 2004; Irvine et al. 2010, 2013). However, while people often express a desire to interact with nature, field observations in Sheffield, UK, revealed that once inside parks visitors tended to prefer locations with lower tree cover (Irvine et al. 2010). Furthermore, landscape preference studies suggest that people from western cultures tend to prefer landscapes resembling savannah, where few trees are scattered across an open grassy landscape (Kaplan and Kaplan 1989). Depending on the ecological context of a city such landscapes are not necessarily the most biodiverse or natural. On the other hand, dense vegetation in parks has been associated with safety concerns (Parsons 1995; Bjerke et al. 2006) and is not necessarily conducive to some recreational uses of parks (such as ball or other sports, and some forms of children's playgrounds; Ferré et al. 2006; McCormack et al. 2010). Furthermore, some people have a conscious aversion to natural experiences (Bixler and Floyd 1997). These factors may lead to some people avoiding parks with higher levels of tree cover or native remnant vegetation cover.

Australia provides an interesting opportunity to examine the role of tree cover and native remnant vegetation cover in attracting people to parks. Native ecosystems commonly remain or have been rehabilitated within and around Australian cities (Newton et al. 2001; Bekessy et al. 2012), and while many fauna species have declined or become extinct within these areas (Piper and Catterall 2003; Catterall 2009), many populations of native forest birds, mammals and plants still persist (Brady et al. 2011; Moxham and Turner 2011; Shanahan et al. 2011a, b; Daniels and Kirkpatrick 2012; Stagoll et al. 2012). Thus, tree cover and remnant vegetation cover provide measures respectively of the greenness and the ecological value of parks. Here we examine whether tree cover and remnant vegetation cover act as attractants or deterrents using a city-wide analysis of park visitation patterns in Brisbane, a subtropical city on the east coast of Australia. Specifically we (i) determine whether visitation is biased toward parks with higher levels of tree cover and native remnant vegetation cover, and (ii) investigate whether demographic factors, socio-economic variables, or a person's nature orientation (measured using the nature relatedness scale) correlate with visiting parks with higher levels of tree cover and native remnant vegetation cover.

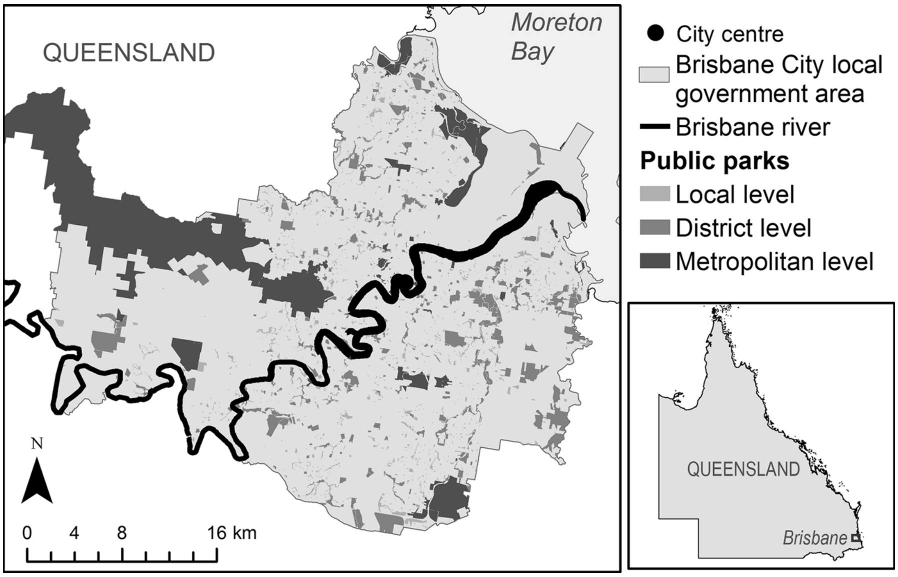
Methods

Brisbane is a subtropical city located in Queensland, Australia, occupying 1,380 km^2. In 2011 the city supported an estimated population of 1,090,000 people. It has considerable amounts of public parkland, and these parks are distributed rather evenly both spatially and socio-economically across the city (Shanahan et al. 2014). We identified and spatially delimited all publicly accessible outdoor parkland areas provided in the region using information from Brisbane City Council, the Queensland Government and utilities providers (see Fig. 1).

Survey participants and procedure

We conducted an urban lifestyle survey on Brisbane residents in November 2012 (1,479 respondents). This was delivered online through a market research company (Q&A Market Research Ltd) to a subset of people enrolled in their survey database. Participants were invited to complete the survey according to several nested stratification criteria that ensured the sample reflected a range of demographic groups, a broad socio-economic spread, and an even spatial distribution across the city. The stratification rules were that (i) participants were between 18 and 70 years of age inclusive, (ii) the number of participants above and below 40 years of age was equal, (iii) the number of female and male participants was equal, (iv) the income quartiles of the participant group reflected those of the total Brisbane population as determined by 2011 Australian Census data, and (v) participants' addresses were spread evenly among

Fig. 1 Map of Brisbane, Australia, showing the distribution of publicly accessible parks within the city boundary



four spatial zones reflecting the four quartiles of tree cover across the city.

The survey was deployed in late spring prior to the onset of higher summer temperatures. Participants were asked to provide their address or an approximate address (e.g. the nearest street corner or street number range) if preferred for privacy reasons. Participants also provided information on their age (selected from 11 brackets), gender, personal annual income (selected from 11 income brackets) and their highest qualification (selected from 11 categories starting from the eighth school year or below up to a post-graduate qualification).

Participants were asked whether they had visited a public park in the last week, and if so were requested to provide the park name, location, or some other identifiable landmark that could assist in its geolocation. Only participants who visited parks are included in the analysis, and visits to areas that are not freely open to the public such as golf courses were omitted from the analysis.

As an indication of each participant's orientation towards nature, survey participants were asked to complete the nature relatedness scale (Nisbet et al. 2009). Participants rate 21 statements using a five-point Likert scale ranging from one (disagree strongly) to five (agree strongly), and collectively the responses to these statements indicate the affective, cognitive, and experiential relationship individuals have with the natural world (Nisbet et al. 2009). Responses to each of the 21 statements were scored and then the average was calculated according to Nisbet et al. (2009). A higher average nature relatedness score indicates a stronger connection with nature. The scale has been shown to differentiate effectively among known groups of nature enthusiasts and those not active in nature activities, as well as those who do and do not self-identify as environmentalists. It also correlates with environmental attitudes and self-reported behaviour (Nisbet et al. 2009).

Measures of vegetation cover in public parks

We used tree cover as a general measure of 'greenness' of parks, including all trees whether native or non-native. We used remnant native vegetation cover to measure the presence of vegetation with high ecological value (Sattler and Williams 1999). Remnant vegetation reflects the pre-urbanized local environment, having either persisted through the urbanization process or been rehabilitated or revegetated. It includes predominantly native plant species (Sattler and Williams 1999) and also provides habitat for fauna (Garden et al. 2006; Shanahan et al. 2011a). In Brisbane the predominant remnant vegetation types are eucalypt woodland and wet sclerophyll forest.

Tree cover was derived from a data layer developed by the Brisbane City Council from an overstory foliage projective cover (FPC) map produced from LiDAR data for the region (acquired between March and June 2009; Armston et al. 2009). Brisbane City Council compared the foliage projective cover maps against a mosaic of high resolution satellite images of the city produced from the WorldView2 instrument (0.5 m resolution) between 22nd March and 21st June 2010. This allowed the removal of misclassified areas from the FPC data layer, as well as updating of areas that were cleared between 2009 and 2010. The foliage projective cover grid was then converted by the Council to a binary tree cover data layer, with areas of non-zero FPC being classified as tree cover. The spatial grain size of the resulting tree cover layer was 2 m. We checked the overall accuracy of the tree cover data layer using visual assessment of 1,000 randomly located points against high resolution Google Earth satellite imagery (Google Earth V6.2, 2012; image captured 16 June 2009). The layer correctly classified 94 % of the points as either 'tree cover' or 'non-tree cover'.

Second, we calculated remnant vegetation cover by measuring the area of each park occupied by naturally occurring or rehabilitated vegetation. The remnant vegetation layer was originally created by the Queensland Government by interpreting satellite imagery and aerial photographs, and this interpretation was later ground-truthed and classified following the classification system outlined by Sattler and Williams (1999). Remnant vegetation patches from 0.5 hectares in size and greater are represented in this dataset, and it includes vegetation that remained as the city developed as well as vegetation that has been restored to remnant or near remnant status. We updated this regional ecosystem map to reflect recent clearing based on the 2010 tree cover map described above. We then reclassified the tree cover data set according to its remnant status. We found that open eucalypt woodland remnant vegetation was commonly mapped as a mosaic in the tree cover layer such that many individual pixels within the vegetation type were classified as non-tree (open eucalypt woodlands have a grassy or herbaceous understorey); we therefore reclassified these individual cells as 'remnant vegetation'. Note that for consistency in analysis small areas of non-tree remnant vegetation categories were excluded (this includes grassland, herbland, healthland, sedgeland and freshwater swamps).

Brisbane City Council categorises public parks into local parks, district parks, and metropolitan (city-wide) parks (see Brisbane City Council 2013). This typology reflects the intended catchment area for parks, as well as the level of service provision and density at which the different kinds of park are provided across the city. In brief, local parks have a low level of infrastructure that caters for a low level of use by people living in the immediate vicinity. The intended catchment is a radius of approximately 500 m. District parks have a medium to high level of infrastructure catering for a medium to high level of use at peak times. The intended catchment is two to three suburbs, or approximately a two kilometre radius. Metropolitan parks have a high level of infrastructure catering for major events and high levels of use over long periods. The intended catchment is the entire metropolitan area of the city. Park size varies significantly among the categories (ANOVA: $F = 241.5$, $p < 0.001$) with local parks being the smallest (mean area = 1.3 ha), district parks moderately sized (mean area = 5.9 ha) and metropolitan parks the largest (mean area = 20.8 ha). Given the difference in facilities and size of parks (which are known to influence park visitation; Cohen et al. 2010) among the three categories, we considered that each type of park could deliver a fundamentally different experience for park visitors. Thus, in the relevant analyses below we only compare levels of tree cover or remnant vegetation cover between parks within each category.

Analysis

All analyses presented here are restricted to respondents who visited parks, who chose to provide an approximate address location which could be geo-referenced, and who fell within the study area for which vegetation and social data were available. This included a total of 670 respondents.

We first assessed whether park visitation rates varied with the degree of tree cover and remnant vegetation cover. To do this we identified the 324 parks that had been visited at least once by the survey respondents (each park was visited between 1 and 65 times), and calculated the proportion of these parks that fell into each of ten vegetation cover deciles for the two measures (i.e. 0–10 % tree cover, 11–20 % tree cover, etc. and the same for remnant vegetation cover). This formed our sample of the potential pool of parks that could be visited (we did not use all parks in the city because we were unable to make any assumptions about relative frequency of visits to non-visited parks). We calculated the proportion of all visits within our sample that were to parks in each of the tree cover and remnant vegetation cover categories. We tested for a difference between the two distributions using a Chi squared goodness of fit test based on the assumption that the availability of parks in each category is the expected distribution of park visits given random selection. All statistical analyses were performed in R v2.13.0 (R Core Team 2012).

To determine whether tree cover and remnant vegetation cover had an important role in attracting or deterring park users, for each individual park visit we calculated the difference in each vegetation cover variable between the park visited and the park closest to the respondent's address within the same park category. For example, if a respondent visited a metropolitan level park this was compared to the metropolitan level park closest to their home. The closest parks were identified based on the travel distance between each park and the respondent's address. A positive difference value indicated a visit was to a park with greater tree cover or remnant vegetation cover than that closest to the person's home, a negative value a park with lower cover, and a value of zero indicated the person either visited the closest park or one with identical tree cover or remnant vegetation cover. We interpreted these measures as a proxy for whether a person makes some extra effort to travel further for parks with higher levels of tree cover and remnant vegetation cover.

We used linear mixed effects models (using the R statistical package lme4) to examine the relationship between difference in tree cover and difference in remnant vegetation cover (as response variables) and a range of predictor variables that could potentially influence a person's engagement with park use.

Respondent number was treated as a random effect as some people reported visiting more than one park in the previous week (i.e. some respondents had multiple measures). The predictor variables were the respondent's nature relatedness score (a continuous variable), age (an ordinal variable as respondents selected their age from 11 age brackets), gender (male = 1, female = 2), income (an ordinal variable based on 11 income brackets), highest qualification (an ordinal variable based on groupings of similar levels of achievement), the category of the park visited (ordinal; 1 = local level park, 2 = district level park, 3 = metropolitan level park), and the difference in size between the park visited and the closest option. To examine community-level differences we also included a neighbourhood socio-economic indicator, the Index of Relative Socio-economic Disadvantage (IRSD; Australian Bureau of Statistics 2008); this index was assigned based on the value for the neighbourhood in which a person lived (derived from the 2011 Australian census for the smallest available geographic area, Statistical Area 1). Higher IRSD values indicate greater socio-economic advantage, and as this variable was negatively skewed we used a reflected square root transformation. Because there are gaps in the availability of IRSD data in Brisbane not all park visits could be included in the mixed model analysis. The final data set for which all variables could be calculated was 1,078 visits undertaken by 670 respondents. We checked to ensure the scale of multicollinearity between the predictor variables was acceptable using the variance inflation factor.

We tested all possible combinations of the eight variables (255 models) and ranked them based on Akaike's Information Criterion (AIC). For each model we calculated the change in AIC (ΔAIC) and Akaike weight as a measure of the probability that it provided the most parsimonious fit of the models considered. We calculated the model averaged parameter estimates and relative importance of each by calculating the summed Akaike weights (Burnham and Anderson 2002), and then standardised these summed weights between 0 and 1 (a high value indicates that a variable consistently appeared in the more parsimonious models).

Results

Park visitation closely reflected the availability of parks with respect to tree cover and remnant vegetation cover (Fig. 2), with no significant differences between the expected number of visits given the distribution of parks across the vegetation cover gradients (tree cover: $\chi^2 = 1.37$; remnant vegetation $\chi^2 = 0.61$). However, visual inspection of Fig. 2 suggests that parks with low to moderate levels of tree cover might have attracted slightly more visits than expected.

A total of 79 % of all park visits were to parks further from home than the closest park in the relevant category, suggesting a common propensity to select parks based on more criteria than distance alone. Mixed model analysis indicated significant heterogeneity in park visitation within the population (Tables 1, 2). The most parsimonious models (where $\Delta\text{AIC} \leq 2$) indicated that people with high nature

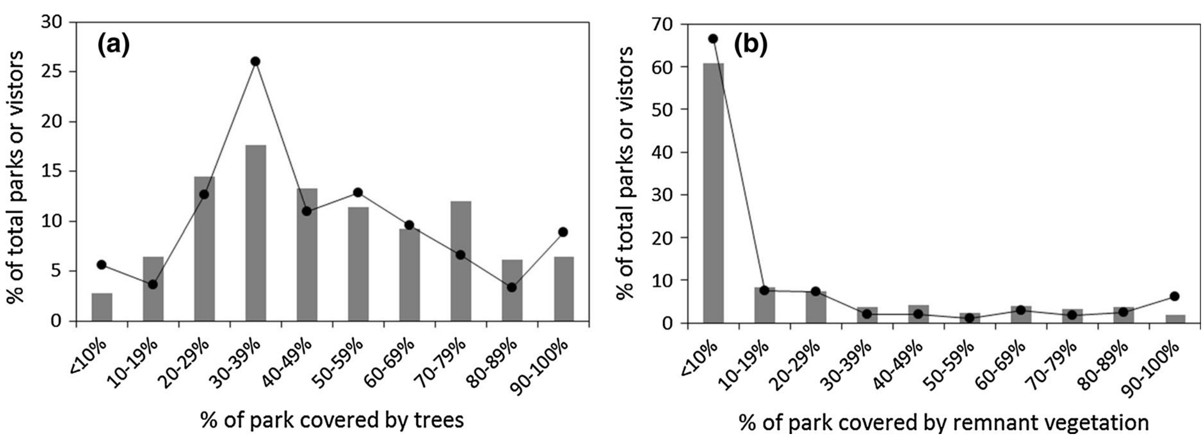


Fig. 2 The percentage of parks visited by survey respondents with different levels of **a** percent tree cover in the park and **b** percent remnant vegetation cover in the park, and the proportion of park-visitors from the Brisbane survey who visited those parks (*black lines*)

relatedness were more likely to travel further for parks with high tree cover and high remnant vegetation cover, and that those living within neighbourhoods of higher socio-economic advantaged were less likely (Tables 1, 2). The coefficient was highest for nature relatedness for both response variables, and this translated into a clear positive relationship between average nature relatedness scores of people who visit parks and the level of vegetation cover within those parks (Fig. 3). While gender was also important for both response variables, the relationship was not in a consistent direction for males and females; females tended to travel further for parks with high tree cover, but the converse was true for parks of high remnant vegetation. Age and income were relatively poor yet positive predictor variables, and highest qualification was a moderately strong and positive predictor (Tables 1, 2).

Both of the physical park characteristics considered here were relatively important variables. The difference between the visited park size and the closest park size showed a positive but very weak relationship with the vegetation cover variables in all instances (Tables 1, 2). This suggests that the larger parks that people travel further to visit tend to have slightly higher levels of tree cover and remnant vegetation cover. Park category was also an important variable (Tables 1, 2), with a negative coefficient suggesting that there was less selection for parks with more vegetation cover at the metropolitan park scale than the local park scale.

Discussion

The revealed preferences shown in this study indicate that tree cover and remnant vegetation cover have limited overall influence on park visitation rates. However, there is some indication that urban residents prefer to visit parks with moderate to low levels of tree cover. This result highlights a paradox; while more vegetated locations provide enhanced experiences with nature and may even provide greater wellbeing benefits, they are not necessarily the most preferred locations to visit. Our results also suggest a mismatch between the needs of people for recreation and the needs of biodiversity for habitat, presenting challenges for creating and managing parkland that delivers recreational ecosystem services as well as landscape sustainability objectives. There are several possible explanations for this pattern. First, it could simply reflect preferences for particular landscapes. There is a significant body of literature that explores people's stated landscape preferences, and evidence suggests that at least in western societies people tend to prefer 'open savannah' style landscapes, with few scattered trees over grass (Kaplan and Kaplan 1989). However, these landscapes do not necessarily provide the best habitat for biodiversity. These preferences could in part be influenced by a perception that safety decreases as vegetation cover increases (Parsons 1995; Bjerke et al. 2006); this is despite evidence that crime, including gun assaults, robbery and burglary, can decrease as vegetation increases (Branas et al. 2011; Troy et al. 2012). A second possibility is that there is a mismatch between perceived levels of nature and reality. Indeed, park visitors in Sheffield, UK, had a very poor ability to identify actual levels of species richness (Dallimer et al. 2012), and the wellbeing benefits people received were found to have a much higher correlation with people's perception of nature rather than actual species richness levels.

Of the social and demographic factors tested here, our results show that people who are more connected to nature tend to visit urban parks with higher levels of tree cover and remnant vegetation cover than those most immediately available to them. This suggests that only a particular subset of the population actually accesses the range of benefits associated with being in more natural environments. This adds to previous work which has shown that people with greater nature relatedness also visit public parks more frequently than those with a lower score (Lin et al. 2014). These results have important policy implications as a common approach for governments is to set green space targets based on proximity to residential areas and minimum area provision (e.g. Natural England 2010; UN-Habitat 2013). Our research highlights that 'access to parks' should not only be measured through area provision and distance targets, but through social characteristics of communities that mean some people will be more likely to exploit available natural spaces (and hence access the associated wellbeing benefits) than others. Furthermore, our results highlight the need to consider the social aspects of people's engagement with public parks when planning for dual outcomes for human wellbeing and biodiversity, as the increased levels of vegetative cover provided through

Table 1 Results from linear mixed models showing the correlation between difference in tree cover between the visited park and that closest to the visitor's home and a range of predictor variables

Model rank	Predictor variables coefficient (t value)							ΔAIC	Akaike weight
	IRSD	Nature relatedness	Highest qualification	Gender (female = 2)	Park category	Age	Park area		
Parameter estimate[relative importance]	*−0.15[1]*	*2.37[0.82]*	*0.38[0.37]*	*0.80[0.66]*	*−0.38[0.57]*	*0.05[0.08]*	*5.0e−7[1]*		
1	−0.15(−0.47)	2.36(1.47)		0.71(0.36)	−0.61(−0.49)		5e−7(9)		0.18
2	−0.15(−0.47)	2.39(1.48)		0.77(0.39)			5e−7(0.03)	0.51	0.14
3	−0.15(−0.48)	2.36(1.46)	0.38(0.86)	0.82(0.42)	−0.66(−0.54)		5e−7(8.86)	1.04	0.10
4	−0.15(−0.48)	2.4(1.5)			−0.63(−0.52)		5e−7(9)	1.31	0.09
5	−0.15(−0.48)	2.39(1.48)	0.37(0.83)	0.89(0.45)			5e−7(8.9)	1.6	0.08
6	−0.15(−0.48)	2.43(1.5)					5e−7(9)	1.83	0.07
7	−0.15(−0.49)	2.41(1.5)	0.37(0.83)		−0.69(−0.56)		5e−7(0.88)	2.39	0.05
8	−0.15(−0.46)			0.91(0.46)	−0.67(−0.54)		5e−7(9)	2.95	0.04
9	−0.15(−0.49)	2.44(1.52)	0.37(0.81)				5e−7(8.9)	2.97	0.04
10	−0.15(−0.46)			0.98(0.5)			5e−7(9.11)	3.51	0.03
11	−0.15(−0.41)		0.38(0.86)	1.02(0.52)	−0.72(−0.58)		5e−7(8.9)	3.98	0.02
12	−0.15(−0.47)				−0.71(−0.57)		5e−7(9.1)	4.34	0.02
13	−0.15(−0.47)		0.37(0.83)	1.1(0.56)			5e−7(9)	4.59	0.02
14	−0.15(−0.47)						5e−7(9.1)	4.93	0.02
15	−0.15(−0.48)	2.23(1.37)		0.57(0.29)	−0.57(−0.46)	0.04(0.58)	5e−7(8.9)	5.16	0.01
16	−0.15(−0.48)		0.37(0.83)		−0.76(−0.62)		5e−7(8.9)	5.43	0.01
17	−0.15(−0.48)	2.24(1.38)		6.35(0.32)		0.04(0.6)	5e−7(9)	5.65	0.01
18	−0.15(−0.49)	2.18(1.33)	0.45(0.99)	0.66(0.34)	−0.62(−0.5)	0.05(0.76)	5e−7(8.78)	5.91	0.01

The *italicized values* show the model averaged parameter estimate and the relative importance of each variable (measured using standardised summed Akaike weights). The table also show the models in the top 95 % set based on cumulative Akaike weight. The results for each predictor variable are shown in the columns (income is not included here as it did not appear in the top 95 % set), where the coefficient indicates the direction of the relationship between the predictor and response variable

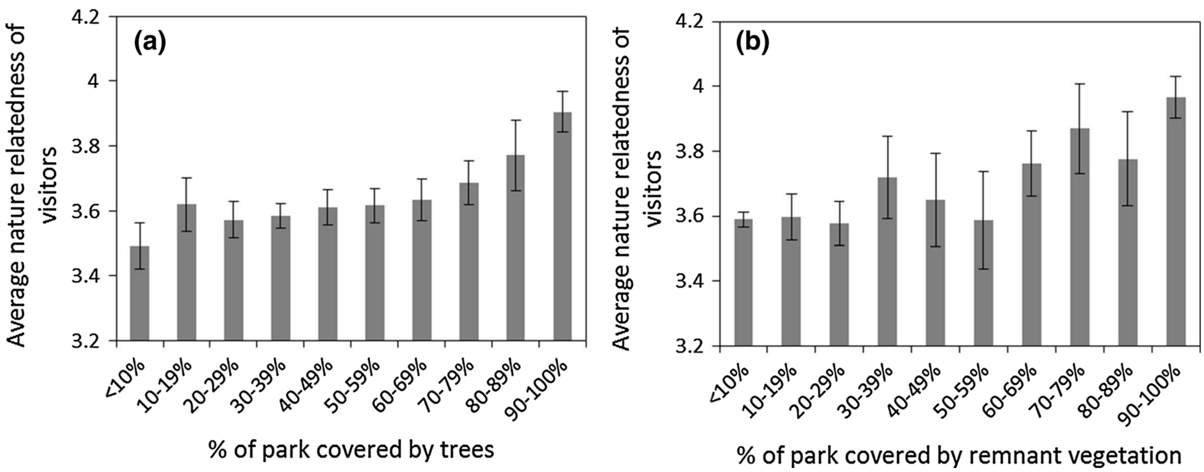


Fig. 3 Average nature relatedness scores of visitors to parks with differing levels of **a** percent tree cover in parks and **b** percent remnant vegetation cover in parks. *Error bars* show the standard error

ecological restoration will not necessarily deliver wellbeing benefits equitably across the population. However, programmes that increase the orientation of city residents toward nature could overcome this issue.

People living in socio-economically advantaged neighbourhoods did not travel further for parks with higher tree cover or remnant vegetation cover than those locally available, though this effect was rather weak. This pattern could reflect the fact that more advantaged communities often have higher levels of neighbourhood vegetation cover and biodiversity (Landry and Chakraborty 2009; Strohbach et al. 2009; Pham et al. 2012; Clarke et al. 2013; van Heezik et al. 2013), and perhaps the need or desire to travel further for high quality natural areas may be lower where neighbourhood greenness is already high. Previous research in Brisbane has shown that more advantaged neighbourhoods do tend to have higher levels of tree cover (Shanahan et al. 2014). These are important findings as inequalities in access to natural landscapes could exacerbate existing social disadvantage (Heynen et al. 2006), particularly through inequitable access to the resulting wellbeing benefits. These inequities could be addressed by providing higher quality natural environments close to people's homes, and ensuring that access to these environments remains equitable across socio-economic gradients.

Park characteristics are well known to influence park visitation (Ho et al. 2005; Wende et al. 2012; Jim and Shan 2013; Zanon et al. 2013; Lin et al. 2014; Pleson et al. 2014), and we found that park size was an important predictor of the relative vegetation cover in visited parks. Furthermore, tree cover and remnant vegetation cover were more important factors in park selection at the local scale than the district or metropolitan park scale. This result could have occurred simply because there are fewer parks available at the larger metropolitan park scale such that the minimum possible travel distance from most locations is already quite significant and longer trips are not feasible. It would be interesting to discover how far people with different levels of nature relatedness are prepared to travel to more natural locations, and the answer to this question could help inform how explicit targets for the provision of parks with different levels of vegetation cover could be set.

While enhancing visitation to parks could assist in achieving dual outcomes for biodiversity and recreation, it could also put pressure on the biodiversity values of parks. For example, greater numbers of visitors can introduce weeds, create disturbance, damage vegetation and lead to soil compaction (Bigirimana et al. 2011; Hauru et al. 2012; Zhou and Chu 2012; Sikorski et al. 2013). However, given that urban habitats are highly threatened by degradation and loss, in many instances they may arguably be more valuable for the educational and experiential opportunities they offer than for their contribution to biodiversity conservation. It may be necessary, however, to weigh up this trade-off on a case-by-case basis.

Our work characterises human-environment interactions across urban landscapes, an approach that is

Table 2 Results from linear mixed models showing the correlation between difference in remnant vegetation cover between the visited and that closest to the visitor's home and a range of predictor variables

Model rank	Predictor variables coefficient (t value)							ΔAIC	Akaike weight
	IRSD	Nature relatedness	Highest qualification	Gender (female = 2)	Park category	Age	Park area		
Parameter estimate [relative importance]	*−0.15[1]*	*2.37[0.82]*	*0.38[0.37]*	*0.80[0.66]*	*−0.38[0.57]*	*0.05[0.08]*	*5.0e−7[1]*		
1	−0.58(1)	2.58(0.82)	0.28(0.36)	−0.99(0.70)	−6.94(1)	0.03(0.08)	8.4e−7(1)	0	0.34
2	−0.58(−1.56)	2.61(1.38)		−1.06(−0.46)	−6.93(−4.81)		8e−7(12.55)	1.2	0.19
3	−0.58(−1.56)	2.61(1.38)	0.27(0.52)	−1.06(−0.46)	−6.93(−4.81)		8e−7(12.55)	1.7	0.15
4	−0.58(−1.55)	2.55(1.36)			−6.81(−4.79)		8e−7(12.55)	2.87	0.08
5	−0.58(−1.55)	2.55(1.36)	0.28(0.55)		−6.93(−4.81)		8e−7(12.43)	3.03	0.07
6	−0.58(−1.55)			−0.83(−0.36)	−7.00(−4.85)		8e−7(12.63)	4.23	0.04
7	−0.58(−1.55)		0.27(0.52)	−0.75(−0.33)	−7.00(−4.87)		8e−7(12.51)	4.64	0.03
8	−0.58(−1.54)				−6.96(−4.84)		8e−7(12.63)	5.05	0.03
9	−0.58(−1.56)	2.51(1.32)		−1.15(−0.5)	−6.91(−4.78)	0.029(0.36)	8e−7(12.51)	5.82	0.02

The *italicized values* show the model averaged parameter estimate and the relative importance of each variable (measured using standardised summed Akaike weights). The table also show the models in the top 95 % set based on cumulative Akaike weight. The results for each predictor variable are shown in the columns (income is not included here as it did not appear in the top 95 % set), where the coefficient indicates the direction of the relationship between the predictor and response variable critical for supporting the development of sustainable landscape design approaches (Wu 2013). We have found that over all tree cover and remnant vegetation cover have a relatively limited role in attracting people to parks, yet we have also discovered that there are groups within the population for whom this is not the case; in particular people who are more connected to nature. This subset of people is likely to gain much enhanced experiences of nature and could potentially receive greater wellbeing benefits. There are of course, many considerations in designing and providing urban green spaces including, for example, the provision of biophysical ecosystem services, landscape sustainability objectives, facilitation of active travel, use of an areas for socialisation, community safety and the availability of appropriate sporting facilities (Bolund and Hunhammar 1999; Forsyth and Musacchio 2005; Giles-Corti et al. 2005; Crawford et al. 2008; Cohen et al. 2010; Peschardt et al. 2012); of course, not all of these objectives will need to be met in the same spaces. However, we have demonstrated that to deliver greater biodiversity conservation and recreation opportunity in the same locations a range of other social or educational interventions may be required to enhance people's connection to nature.

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